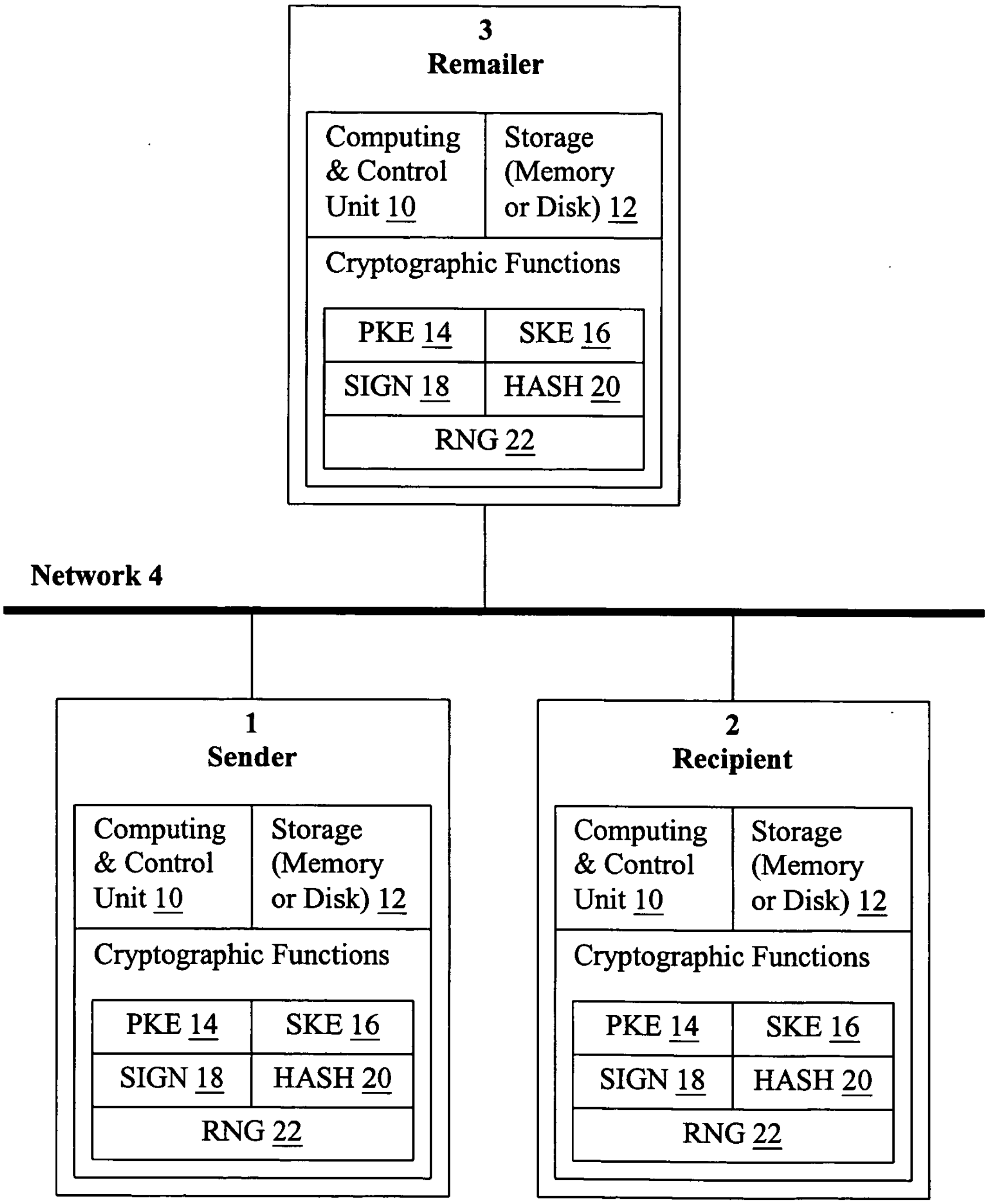
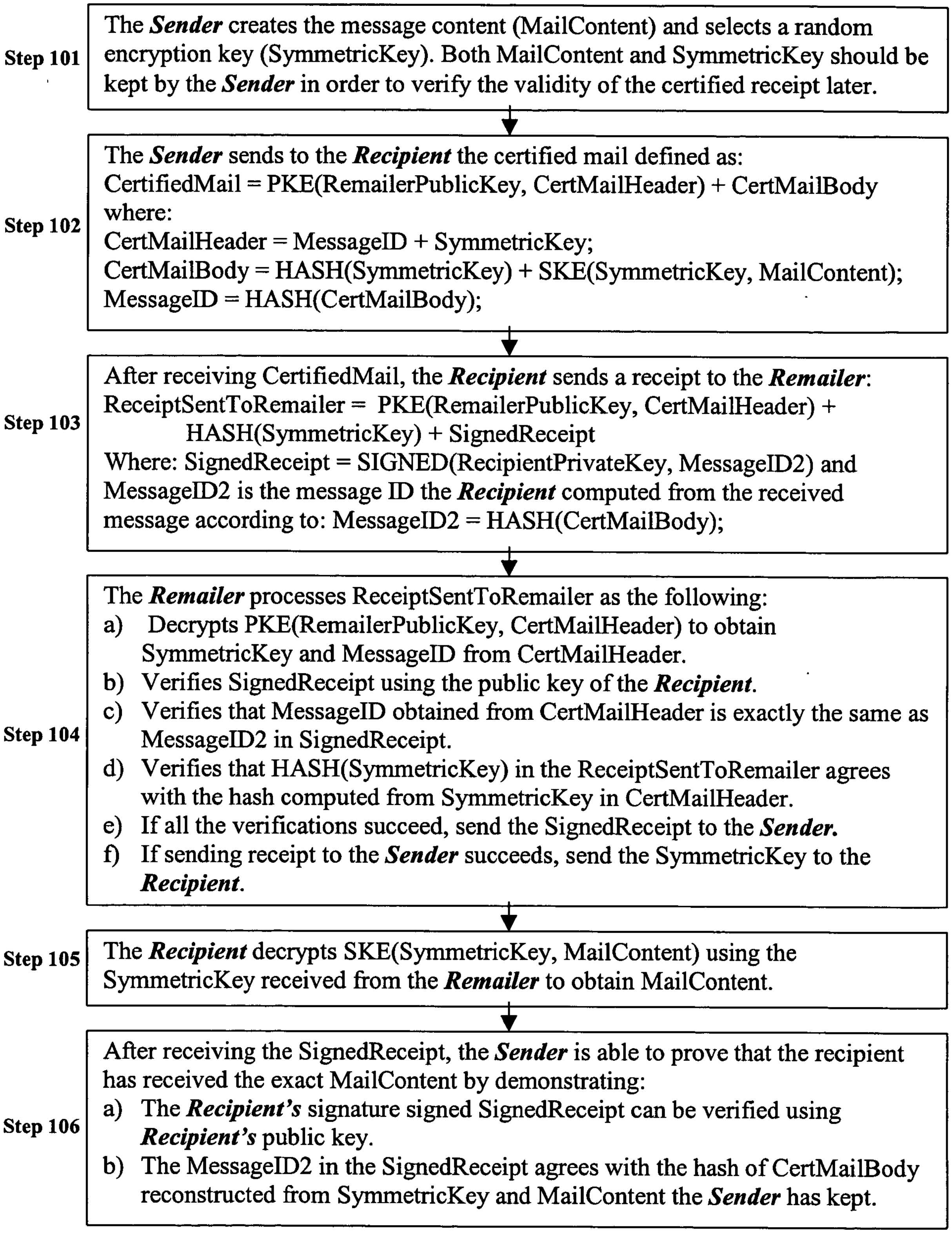

3
Remailer
Computing & Control Unit 10
Storage (Memory or Disk) 12
Cryptographic Functions
PKE 14
SKE 16
SIGN 18
HASH 20
RNG 22
Network 4
1
Sender
Computing & Control Unit 10
Storage (Memory or Disk) 12
Cryptographic Functions
PKE 14
SKE 16
SIGN 18
HASH 20
RNG 22
2
Recipient
Computing & Control Unit 10
Storage (Memory or Disk) 12
Cryptographic Functions
PKE 14
SKE 16
SIGN 18
HASH 20
RNG 22

Figure 1.



Step 101

The ***Sender*** creates the message content (MailContent) and selects a random encryption key (SymmetricKey). Both MailContent and SymmetricKey should be kept by the ***Sender*** in order to verify the validity of the certified receipt later.

Step 102

The ***Sender*** sends to the ***Recipient*** the certified mail defined as:
CertifiedMail = PKE(RemailerPublicKey, CertMailHeader) + CertMailBody
where:
CertMailHeader = MessageID + SymmetricKey;
CertMailBody = HASH(SymmetricKey) + SKE(SymmetricKey, MailContent);
MessageID = HASH(CertMailBody);

Step 103

After receiving CertifiedMail, the ***Recipient*** sends a receipt to the ***Remailer***:
ReceiptSentToRemailer = PKE(RemailerPublicKey, CertMailHeader) + HASH(SymmetricKey) + SignedReceipt
Where: SignedReceipt = SIGNED(RecipientPrivateKey, MessageID2) and MessageID2 is the message ID the ***Recipient*** computed from the received message according to: MessageID2 = HASH(CertMailBody);

Step 104

The ***Remailer*** processes ReceiptSentToRemailer as the following:

a) Decrypts PKE(RemailerPublicKey, CertMailHeader) to obtain SymmetricKey and MessageID from CertMailHeader.
b) Verifies SignedReceipt using the public key of the ***Recipient***.
c) Verifies that MessageID obtained from CertMailHeader is exactly the same as MessageID2 in SignedReceipt.
d) Verifies that HASH(SymmetricKey) in the ReceiptSentToRemailer agrees with the hash computed from SymmetricKey in CertMailHeader.
e) If all the verifications succeed, send the SignedReceipt to the ***Sender.***
f) If sending receipt to the ***Sender*** succeeds, send the SymmetricKey to the ***Recipient***.

Step 105

The ***Recipient*** decrypts SKE(SymmetricKey, MailContent) using the SymmetricKey received from the ***Remailer*** to obtain MailContent.

Step 106

After receiving the SignedReceipt, the ***Sender*** is able to prove that the recipient has received the exact MailContent by demonstrating:

a) The ***Recipient's*** signature signed SignedReceipt can be verified using ***Recipient's*** public key.
b) The MessageID2 in the SignedReceipt agrees with the hash of CertMailBody reconstructed from SymmetricKey and MailContent the ***Sender*** has kept.

Figure 2

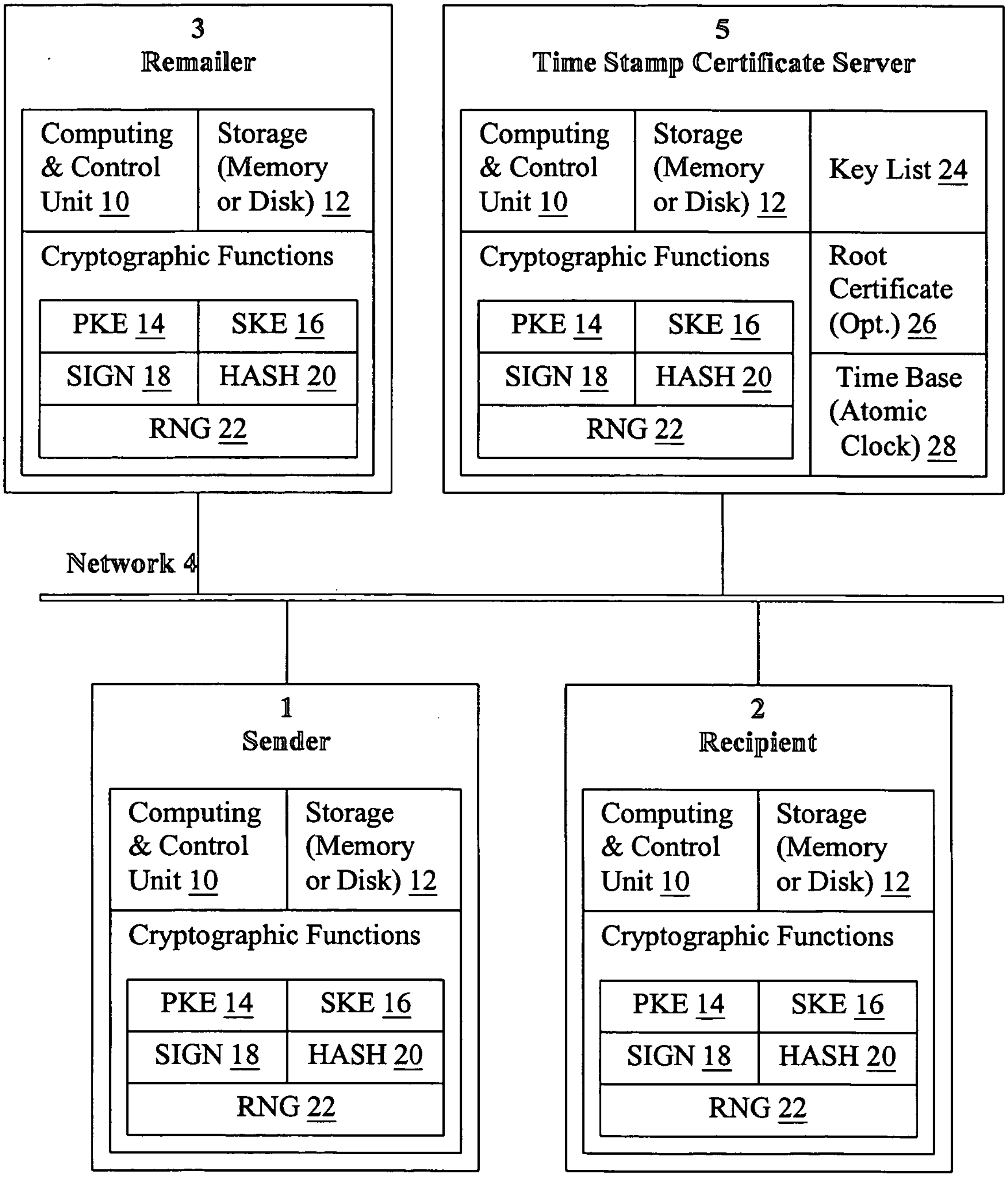
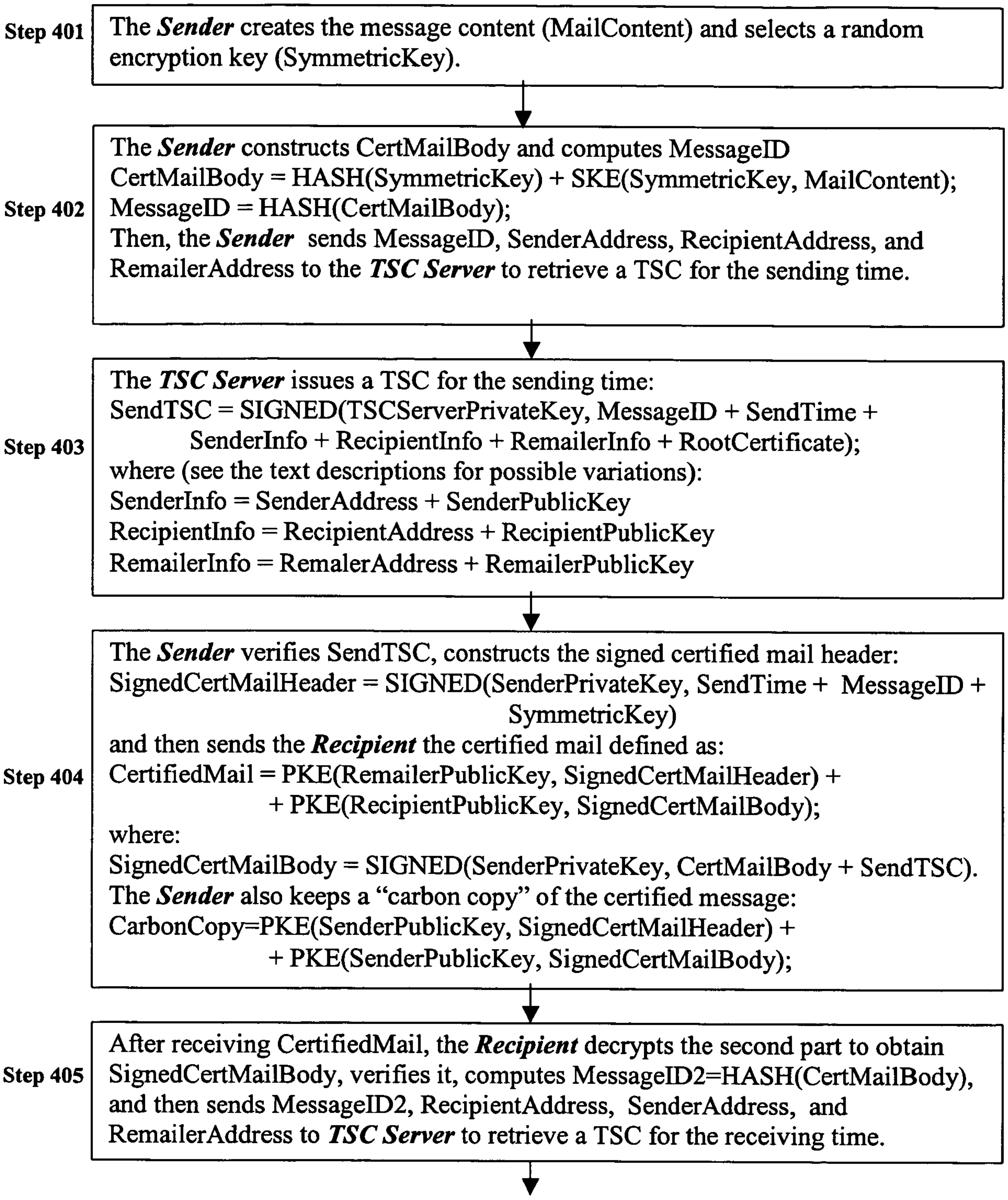

3
Remailer
Computing & Control Unit 10
Storage (Memory or Disk) 12
Cryptographic Functions
PKE 14
SKE 16
SIGN 18
HASH 20
RNG 22
5
Time Stamp Certificate Server
Computing & Control Unit 10
Storage (Memory or Disk) 12
Key List 24
Cryptographic Functions
PKE 14
SKE 16
SIGN 18
HASH 20
RNG 22
Root Certificate (Opt.) 26
Time Base (Atomic Clock) 28
Network 4
1
Sender
Computing & Control Unit 10
Storage (Memory or Disk) 12
Cryptographic Functions
PKE 14
SKE 16
SIGN 18
HASH 20
RNG 22
2
Recipient
Computing & Control Unit 10
Storage (Memory or Disk) 12
Cryptographic Functions
PKE 14
SKE 16
SIGN 18
HASH 20
RNG 22

Figure 3.



Step 401 The ***Sender*** creates the message content (MailContent) and selects a random encryption key (SymmetricKey).

Step 402 The ***Sender*** constructs CertMailBody and computes MessageID
CertMailBody = HASH(SymmetricKey) + SKE(SymmetricKey, MailContent);
MessageID = HASH(CertMailBody);
Then, the ***Sender*** sends MessageID, SenderAddress, RecipientAddress, and RemailerAddress to the ***TSC Server*** to retrieve a TSC for the sending time.

Step 403 The ***TSC Server*** issues a TSC for the sending time:
SendTSC = SIGNED(TSCServerPrivateKey, MessageID + SendTime + SenderInfo + RecipientInfo + RemailerInfo + RootCertificate);
where (see the text descriptions for possible variations):
SenderInfo = SenderAddress + SenderPublicKey
RecipientInfo = RecipientAddress + RecipientPublicKey
RemailerInfo = RemalerAddress + RemailerPublicKey

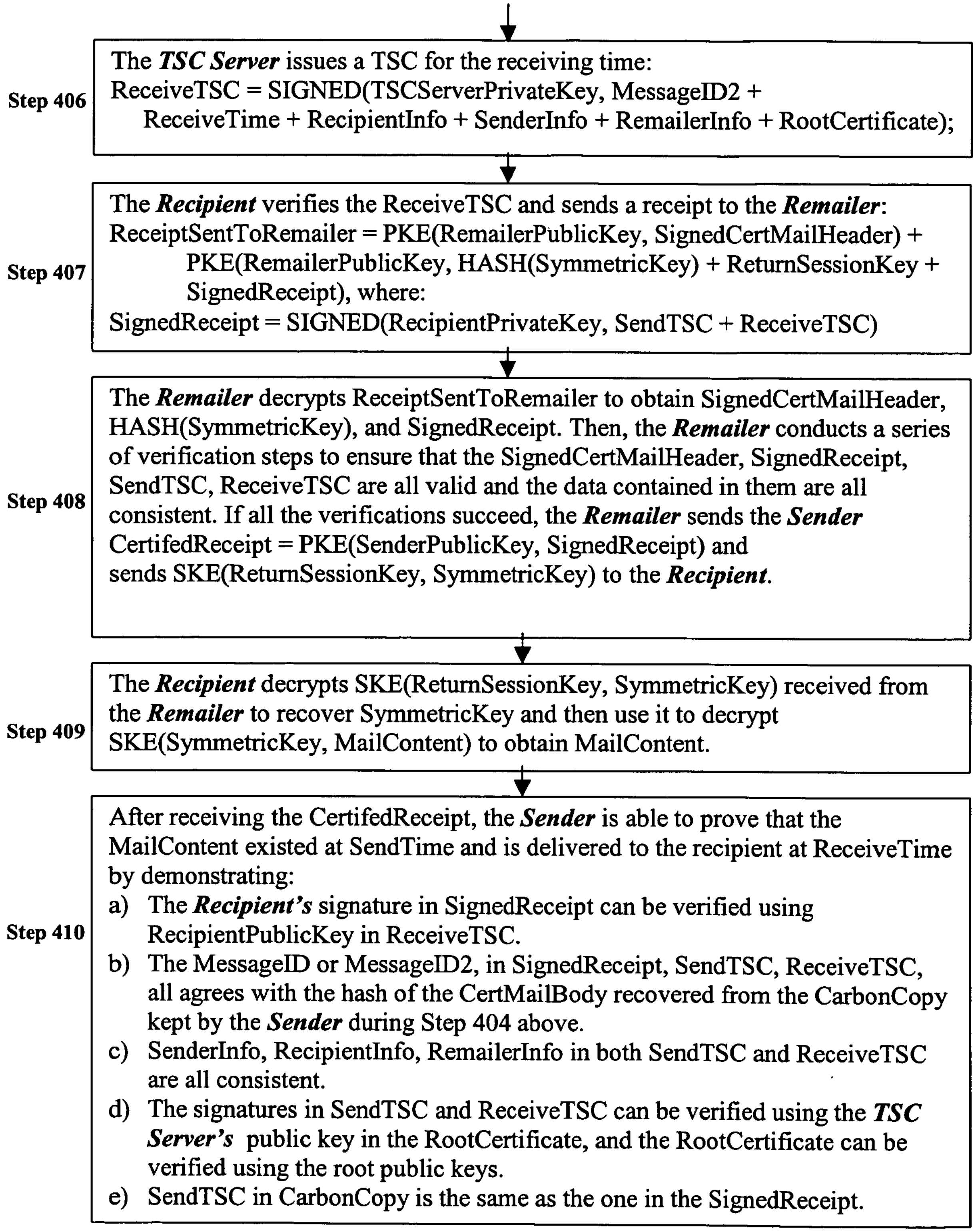
Step 404 The ***Sender*** verifies SendTSC, constructs the signed certified mail header:
SignedCertMailHeader = SIGNED(SenderPrivateKey, SendTime + MessageID + SymmetricKey)
and then sends the ***Recipient*** the certified mail defined as:
CertifiedMail = PKE(RemailerPublicKey, SignedCertMailHeader) + + PKE(RecipientPublicKey, SignedCertMailBody);
where:
SignedCertMailBody = SIGNED(SenderPrivateKey, CertMailBody + SendTSC).
The ***Sender*** also keeps a "carbon copy" of the certified message:
CarbonCopy=PKE(SenderPublicKey, SignedCertMailHeader) + + PKE(SenderPublicKey, SignedCertMailBody);

Step 405 After receiving CertifiedMail, the ***Recipient*** decrypts the second part to obtain SignedCertMailBody, verifies it, computes MessageID2=HASH(CertMailBody), and then sends MessageID2, RecipientAddress, SenderAddress, and RemailerAddress to ***TSC Server*** to retrieve a TSC for the receiving time.

Continued to Figure 4b

Figure 4a

Continued from Figure 4a



Step 406

The ***TSC Server*** issues a TSC for the receiving time:
ReceiveTSC = SIGNED(TSCServerPrivateKey, MessageID2 + ReceiveTime + RecipientInfo + SenderInfo + RemailerInfo + RootCertificate);

Step 407

The ***Recipient*** verifies the ReceiveTSC and sends a receipt to the ***Remailer***:
ReceiptSentToRemailer = PKE(RemailerPublicKey, SignedCertMailHeader) + PKE(RemailerPublicKey, HASH(SymmetricKey) + ReturnSessionKey + SignedReceipt), where:
SignedReceipt = SIGNED(RecipientPrivateKey, SendTSC + ReceiveTSC)

Step 408

The ***Remailer*** decrypts ReceiptSentToRemailer to obtain SignedCertMailHeader, HASH(SymmetricKey), and SignedReceipt. Then, the ***Remailer*** conducts a series of verification steps to ensure that the SignedCertMailHeader, SignedReceipt, SendTSC, ReceiveTSC are all valid and the data contained in them are all consistent. If all the verifications succeed, the ***Remailer*** sends the ***Sender*** CertifedReceipt = PKE(SenderPublicKey, SignedReceipt) and sends SKE(ReturnSessionKey, SymmetricKey) to the ***Recipient***.

Step 409

The ***Recipient*** decrypts SKE(ReturnSessionKey, SymmetricKey) received from the ***Remailer*** to recover SymmetricKey and then use it to decrypt SKE(SymmetricKey, MailContent) to obtain MailContent.

Step 410

After receiving the CertifedReceipt, the ***Sender*** is able to prove that the MailContent existed at SendTime and is delivered to the recipient at ReceiveTime by demonstrating:

a) The ***Recipient's*** signature in SignedReceipt can be verified using RecipientPublicKey in ReceiveTSC.
b) The MessageID or MessageID2, in SignedReceipt, SendTSC, ReceiveTSC, all agrees with the hash of the CertMailBody recovered from the CarbonCopy kept by the ***Sender*** during Step 404 above.
c) SenderInfo, RecipientInfo, RemailerInfo in both SendTSC and ReceiveTSC are all consistent.
d) The signatures in SendTSC and ReceiveTSC can be verified using the ***TSC Server's*** public key in the RootCertificate, and the RootCertificate can be verified using the root public keys.
e) SendTSC in CarbonCopy is the same as the one in the SignedReceipt.

Figure 4b